SEMI-ANNUAL REPORT

RESEARCH IN SPACE-RELATED SCIENCES
May 1, 1969 -- October 31, 1969

UNIVERSITY OF FLORIDA

NASA RESEARCH GRANT ~~NsG 542~~
NGL-10-005-005

SEMI-ANNUAL REPORT ON THE PROGRAM OF
RESEARCH IN SPACE-RELATED SCIENCES ESTABLISHED
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for the period

May 1, 1969 - October 31, 1969

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INTRODUCTION

This document represents the required semi-annual report for the NASA-sponsored program of research in space-related sciences at the University of Florida. The program has been in continuous operation since November 1, 1963, and to date it has involved a total of 47 different projects in 17 science, engineering, medical, and business departments of the University (see Table 1).

The present report concerns those projects which were active during the six-month period from May 1, 1969 through October 31, 1969. Descriptions of the work of the individual projects were prepared in each case by the appropriate principal investigators, and those were then edited and assembled under the supervision of the Chairman of the University of Florida NASA Steering Committee. The project budgets inevitably reflect the reduced rate of expenditure now imposed on the entire program. However, it is felt that despite the necessary cut-backs, a commendable rate of progress and publication has been maintained from the momentum already present in the on-going research program.

During the present report period an extensive new proposal for continued NASA support was prepared around the present core of highly successful, strongly space-related research in stellar & planetary atmospheres. This proposal is currently under review by NASA.

TABLE I: HISTORY OF PROJECTS UNDER THE NASA INSTITUTIONAL GRANT

BUDGETS (INCLUDING OVERHEAD)

*PROJECT	DEPARTMENT	INVESTIGATOR	PROJECT DESCRIPTION	1964	1964-65	1965-66	1966-67	1967-68	1968-69	1969-70
A01	Astronomy	A. G. Smith	Study of 20 Mc Signal of Satellite	$ 7,185	$ 5,125	Compl.	--	--	--	--
A02	Astronomy	T. D. Carr	Use of Arecibo Radio Telescope	6,974	10,875	$ 10,050	$ 10,000.	Compl.	--	--
A03	Astronomy	A. G. Smith	Low Frequency Jovian Radio Spectrum	34,435	34,625	38,562	26,000	Compl.	--	--
A04	Aerospace	D. T. Williams	Plastic Mirrors	10,200	2,000	Term.	--	--	--	--
A05	Physics	F. E. Dunnam	Nuclear Astrophysics	26,500	33,100	25,600	14,000	--	--	--
A06	Aerospace	M. H. Clarkson	Magnetofluidmechanics	52,000	62,000	50,000	25,000	$ 12,400	$ 18,000	9,000
A07	Aerospace	K. Millsaps	Electric Boundary Layers	17,600	17,600	**	--	--	--	--
A08	Eng. Mech.	W. A. Nash	Behavior of Inflatable Structures	15,350	15,625	Compl.	--	--	--	--
A09	Eng. Mech.	J. Siekmann	Fluids in Low Gravitational Fields	9,700	10,690	15,012	11,000	Compl.	--	--
A10	Metallurgy	F. N. Rhines	High Temperature Oxidation	6,500	8,375	9,175	9,170	Compl.	--	--
A11	Metallurgy	R. Reed-Hill	Fracture of Hf-Zr Alloys	8,800	9,925	Compl.	--	--	--	--
A12	Metallurgy	R. Reed-Hill	Low Temperature Fracture of Mg	7,000	8,175	Compl.	--	--	--	--
A13	Physics	A. A. Broyles	Fluid States of Matter	26,500	26,875	18,000	7,200	7,300	--	--
A14	Mathematics	R. Selfridge	Computational Forms for Functions	14,200	Term.	--	--	--	--	--
A15	Chemistry	E. Muschlitz	Molecular Beam Investigations	32,825	37,500	16,250	16,000	4,800	--	--
A16	Physics	T. L. Bailey	Collisions of Electrons & Molecules	17,500	22,500	24,600	20,000	12,100	--	--
A17	Nuclear Eng.	R. E. Uhrig	Nuclear Propulsion	27,800	26,700	27,800	--	--	--	--
A18	Physics	A. E. S. Green	Radiation in Planetary Atmospheres	12,500	Compl.	--	--	--	--	--
A19	Astronomy	K.-Y. Chen	Photometry of Variable Stars	--	8,700	8,688	4,800	6,100	6,240	5,500
A20	Chemistry	J. Winefordner	Flame and Arc Spectrophotometry	--	13,000	**	--	--	--	--
A21	Physics	A. E. S. Green	Theoretical Nuclear Physics	--	1,500	**	--	--	--	--
A22	Aerospace	K. Millsaps	Hydrothermodynamics of Jets	--	5,129	14,075	18,280	11,400	--	--
A23	Radiology	H. L. Cromroy	Hyperbaric Oxygen and Aging	--	--	22,000	13,690	6,900	6,960	2,300
A24	Aerospace	O. E. Myers	Experiments on Color Vision	--	--	6,100	14,000	7,800	10,200	5,000
A25	Chem. Eng.	R. W. Fahien	Turbulent Diffusion of Heat & Mass	--	--	14,375	15,000	9,000	--	--
A26	Elec. Eng.	A. P. Sage	Nonlinear Dynamic Processes	--	--	12,675	12,500	Compl.	--	--
A27	Chemistry	S. O. Colgate	Scattering in Molecular Beams	--	--	20,000	19,000	11,200	12,000	6,000
A28	Astronomy	G. C. Omer	Astronomical Study of Gravity	--	--	8,013	8,160	5,800	5,760	3,000
A29	Aerospace	B. M. Leadon	Gasdynamics of Strong Shock Waves	--	--	--	20,000	12,500	15,600	8,500
A30	Chemistry	G. H. Myers	Reactions of Excited Atoms and Molecules	--	--	--	12,600	9,600	9,600	4,500
A31	Eng. Mech.	J. Siekmann	Pulsating Incompressible Liquids	--	--	--	11,000	Compl.	--	--
A32	Metallurgy	R. Reed-Hill	Deformation in Ti at Low Temperature	--	--	--	10,390	7,400	--	--
A33	Physiology	A. B. Otis	Ventilatory Effect of Phonation	--	--	--	3,720	3,800	5,640	3,000
A34	Physics	C. F. Hooper	Spectral Line Broadening in Plasmas	--	--	--	15,000	11,200	12,000	6,000
A35	Physics	R. C. Isler	Excited States of Atmospheric Gases	--	--	--	11,200	9,000	9,000	4,500
A36	Psychology	W. B. Webb	Comparative Study of Sleep Patterns	--	--	--	7,020	5,300	5,400	--
A37	Management	J. H. James	Research Spin-Off to Fla. Industry	--	--	--	13,400	10,700	--	--
A38	Mgmt/Soclgy	Iutaka/W.A. Hill	Evaluation of Scientists' Performance	--	--	--	--	--	13,920	7,875
A39	Aerospace	M. H. Clarkson	Scientist's Role in Societal Problems	--	--	--	--	--	1,200	--
A41	Physiology	M. J. Fregly	Metabolic Response to Hyperbaric O$_2$	--	--	--	--	5,000	8,040	4,000
A42	Chemistry	N. Y. Ohrn	Wave Functions of Excited States	--	--	--	--	6,500	--	--
A43	Chemistry	Wm. Weltner	High Temperature Molecules	--	--	--	--	6,400	--	--
A44	Elec. Eng.	J. Salz	Space Communications by Phase-lock	--	--	--	--	10,000	--	--
A46	Mech. Eng.	R. K. Irey	Heat Transfer to Liquid Helium II	--	--	--	--	6,700	--	--
A47	Metallurgy	F. N. Rhines	Rupture in Dilute Uranium Alloys	--	--	--	--	5,800	--	--
A52	Psychiatry	G. W. Barnard	Cardiovascular Responses to Stress	--	--	--	--	5,400	5,400	3,000
A53	Astronomy	A. Smith/Carr	Major Radioastronomical Array	--	--	--	--	15,900	15,000	11,000
			TOTALS	$333,569	$360,019	$340,975	$348,130	$226,000	$159,960	$ 83,175

*Gaps in the numbering scheme exist because cutback in funding
forced cancellation of originally scheduled projects.

**Funded by AFOSR

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PROJECT A06

MAGNETOFLUIDMECHANICS

1. Department: Aerospace Engineering

2. Principal Investigator: M. H. Clarkson

3. Background: This project has been involved with the analysis and diagnostics of inductive electrodeless discharges operating in atmospheric gases at pressures from several millitorr to atmospheric. Analyses have been performed for both the low-pressure discharge and the thermal arc. Electrostatic probes and spectrographic data obtained in active discharges in argon have demonstrated the validity of the theoretical calculations. Present work is directed toward the development of the discharge for practical applications in lasers, high-pressure gas heaters, and light sources. This project has supported three doctoral dissertations and eleven masters theses.

The research has resulted in the publication of five papers in the scientific journals. Four papers have been presented at national scientific meetings.

4. Progress from May 1, 1969 through October 31, 1969:
    a. Low-Density Electrodeless Discharge
    A new discharge chamber has been designed and is being constructed to investigate the electrodeless discharge in a vortex-stabilized, flowing two-gas system. Spectroscopic measurements will be made to determine the suitability of such a device for a laser discharge.

    b. Angular Flux Distribution from an Orifice
    The experimental measurements of the angular flux distributions from an orifice in rarefied flow have been completed for neon, nitrogen, argon and krypton. The experiments indicate that the distributions cannot be correlated by Reynolds number and that molecular weight and configuration influence the distribution. The results will be reported in a paper which is in preparation.

    c. High-Pressure Electrodeless Discharges
    Initial experiments have been performed with a twelve-inch diameter discharge in both argon and nitrogen at a frequency of 400 KHz and a nominal power input of 40 KW. Support for the continuation of this work will be shifted to another agency in the near future.

5. Publications and Presentations:
    Keefer, D. R. , "A Theory for the Low-Pressure Electrodeless Discharge," AIAA 2nd Fluid and Plasma Dynamics Conference, San Francisco, Calif., June 16-19, 1969, AIAA Paper No. 69-703.

6. <u>Expenditures from May 1, 1969 through October 31, 1969</u>:

Salaries	$ 4,809.00
Expense	2,203.00
Capital equipment	103.00
Total expenditures	$ 7,115.00

PROJECT A19

PHOTOMETRIC INVESTIGATIONS OF STELLAR ATMOSPHERES

1. Department: Physics and Astronomy

2. Principal Investigator: Kwan-Yu Chen

3. Background: The main effort in this program is on the study of
variable stars. Since 1965, selected stars have been observed photo-
electrically using the 12.5-inch Newtonian telescope at the University
of Florida, the 16-inch telescopes at the Kitt Peak National Observa-
tory and the Cerro Tololo Inter-American Observatory, and the Florida
30-inch telescope at Rosemary Hill Observatory. Reduction and analysis
of observational data were carried out with the aid of the IBM 360
computer on campus. In addition, theoretical and computational work on
problems of close binary stars has been carried out in an effort to
improve the analysis of light curves.

4. Progress from May 1, 1969 to October 31, 1969: Analysis of the
light curves of the eclipsing variable BV513 = V701 Centauri is essentially
completed. Light from a third component, comprising as much as 40% of the
total light of the system, has been introduced in order to obtain a
solution fitting the observations. A small orbital eccentricity has been
found, having a value of 0.020 for the eclipsing pair. The intrinsic
color indices, $(B-V)_o$ and $(U-B)_o$, of the three components of this system are:
-0.149 and -0.308, respectively, for the brighter component; -0.027 and
-0.204, respectively for the fainter component; and +0.132 and -0.274,
respectively, for the third companion.

In response to the suggestion of Dr. F. R. West, the visual double
ADS 14893 was observed on three nights. The star did not show light
variations, although one component of the system was observed by him as a
spectroscopic binary.

Mr. T. F. Collins, an NSF Science Faculty Fellow, made UBV observa-
tions of BV423 = AQ Tucanae at Cerro Tololo Inter-American Observatory in
September. These observations covered complete light curves, and the data
are now being reduced.

In collaboration with Dr. W. J. Rhein, now at Florida Technical
University, a theoretical study of the reflection effect in close binary
stars is being continued. With given sets of parameters, Fourier coeffici-
ents have been computed for the light variations in three wavelength
regions due to the reflection effect based on a spherical, black-body
model.

The 12.5-inch telescope is being moved from its old site on the
shore of Biven's Arm Lake to Rosemary Hill. An 18-foot dome for the
instrument is virtually completed, and its auxilliary equipment is being
improved and rebuilt. The telescope is expected to go into operation
at its new site in December.

5. Publications:

Chen, Kwan-Yu and Rhein, Walter J., "Temperature Distributions on the Surfaces of Close Binary Stars," Publ. Astr. Soc. of the Pacific, 81, 387-398, 1969.

Saibejra, Nibondh, "The Main Sequence Eclipsing Binaries and the Restricted Problem of Three Bodies." Master's Thesis, University of Florida, 1969.

6. Expenditures from May 1, 1969, through October 31, 1969:

Salaries	$ 3,384.00
Expense	1,452.85
Capital Equipment	63.40
Total Expenditures	$ 4,899.25

PROJECT A-23

HYPERBARIC OXYGEN AND RADIOSENSITIVITY

1. Department: Radiology and Entomology

2. Principal Investigator: H. L. Cromroy

3. Background: It has been established in the field of radiation biology
that oxygen concentration in a living system at the time of irradiation
strongly influences the obtained response. For example, when the bacterium,
Escherichia coli, is irradiated in a thoroughly oxygenated atmosphere
versus a pure nitrogen atmosphere, there is a change in radiosensitivity, with
the oxygenated bacteria being three times more sensitive than those in
nitrogen at the same exposure doses (1). This and other known effects of
oxygen formed the basis for the present research, which considered the
physiologic effects of hypoxic and hybaroxic conditions produced within a
confined area, as well as the possible modification of these effects when
combined with another physical insult such as ionizing radiation. This work
is best exemplified by the following study supported by the project:

It is generally believed that breathing gas with an oxygen partial
pressure above that of air would increase the radiosensitivity of hypoxic
cancerous tissues without increasing the radiosensitivity of normal tissues.
The study was undertaken to determine if these "non-increases" in normal
tissue sensitivity could be demonstrated. Female Holtzman strain albino
rats, 50 days old, were irradiated with Cobalt-60 (100cm SSD) to a midline
muscle dose of 980 rads at a rate of 42 rads per minute while breathing
gas with oxygen partial pressure at or above 150 mm Hg. For the higher
partial pressures, oxygen was added to the air present in a hyperbaric
chamber to raise the total pressure to two or three atm absolute. Additional
irradiations were done with added helium rather than oxygen. The measure of
radiosensitivity employed was mean survival time (MST) following irradiation.
A total of 100 animals were exposed. In three of four comparisons, the
MSTs of added oxygen groups were significantly less than those of the groups
breathing air at atmospheric pressure, while in four of four comparisons the
MSTs of added helium groups were not significantly different from the air
groups, whose average MST was 10.3 days. These data from rats suggest an
increased radiosensitivity of normal mammalian tissue in animals breathing
oxygen-rich atmospheres.

[1]Cromroy, H. L. and Adler, H. I. , 1962, "Influence of B-Mercaptoethylamine
and oxygen removal on the X-Ray sensitivity of four strains of Escherichia
coli," J. Gen. Microbiology 28, 431-435.

4.   Progress from May 1, 1969 to October 31, 1969: The experimental research on erythropoietin started in January, 1969, has been completed and we are currently analyzing the data. Basically, the study dealt with the effects of hypoxemia and testosterone on erythropoietin production. Erythropoietin or circulating erythropoiesis stimulating factor is an acid glycoprotein hormone that stimulates production of erythrocytes in higher animals. It has been established by other workers that decreased oxygen pressure will increase the level of erythropoietin. We wished to determine physiologic reasons for this increase. The experimental animals used were female Wistor Albino rats which were held under hypoxic conditions for varying levels of time. We believed that a study of this type is basic to consideration of physiological effects of prolonged space travel. Although we are currently analyzing the data, several general conclusions have been reached. First, the erythropoietin production is directly related to renal mass, but only under the conditions of hypoxemia. Next, the effect of testosterone on increased red cell production probably operates through the following mechanisms:

(1)   it increases renal mass, which in turn increases erythropoietin production
(2)   it affects bone marrow
(3)   a third and independent effect which is still undefined.

Finally, erythropoietin production increases with renal mass until it reaches a peak level; then there is no further increase in erythropoietin.

The second project we have been engaged with is that of the combined effect of low levels of ozone and ionizing radiation on animals. We believe this also to be an important project in consideration of prolonged space travel. We are using the chinese hamster as our experimental animal. This animal was selected as it has only 22 for its diploid number of chromosomes. We are using a procedure similar to that used on the astronauts, where we draw blood from the animals, culture, and then study the culture for mitotic figures and count chromosome aberrations. Our major problem has been the development of a reproducible blood culture technique and baseline counts for spontaneous mutation frequency in the population. Since we have overcome this difficulty, we are now submitting animals to different levels of ozone on a p.p.m. basis in the hyperbaric chamber to determine which levels produce aberrations. We then will subject animals to low doses of X-irradiation while they are in the chamber in an ozone atmosphere.

5.   Publications:
Both a master's thesis and a doctoral dissertation which are now being written are supported in part by this project.

6. <u>Expenditures from May 1, 1969 through October 31, 1969</u>:

           Salaries $ 1,360.00

           Expense   1,176.11

           Total Expenditures $ 2,536.11

PROJECT A24

SIMULATION OF VISUAL PROCESSES

1.   Department: Aerospace Engineering

2.   Principal Investigator: O. E. Myers

3.   Background: The "rod" and "cone" cells of the vertebrate retina are known to have refractive indices greater than that of the intercellular media.   The retina may be thought of as a fiber-optics mosaic, with fiber diameters of the same order of magnitude as the wavelength.   In this circumstance, light may reach the chromophore of the cell outer segment only by means of the few allowable bound dielectric waveguide modes.   The effects of dispersion, interactions among neighboring elements of the mosaic, and frequency selectivity in the tapered portion of the cone outer segment are all factors which provide information pertinent to the mediation of color vision; the usual hypothesis of three or more distinct cone photo-pigments is therefore not an absolute requirement.

The purpose of the present study is to establish the extent to which spectoral information might be processed prior to the absorption of light by the receptor photopigment and the subsequent initiation of neural information processing.   Because the physical arrangement scales directly as the wavelength, provided refractive indices are unchanged, scale models can be studied with microwaves if suitable materials are available.

4.   Progress from May 1, 1969 through October 31, 1969:   Interactions among neighboring elements of a fiber-optics mosaic are not directly amenable to mathematical analysis.   It was reasoned, however, that insight into such interactions might result from a study of coaxial cylindrical dielectric waveguides.   The mathematical analysis, neglecting end-effects and assuming isotropic lossless media, for the general case of hybrid modes in a coaxial rod and tube dielectric waveguide has been completed and programmed in Fortran IV.   The boundary conditions give rise to a 12 by 12 matrix, which can be reduced to 4 by 4 by specifying that the rod and the tube have the same refractive index and that they are immersed in a uniform medium.

Direct comparison of modal electric field distributions between theory and experiment will be used to assess the value of experimental data in which the tube is replaced by a cylindrical array of rods.   Experimental results generally suggest a tendency for longer-wavelength radiation to become concentrated in the larger diameter rods.   The "signature" of a wavefront transmitted through a fiber optics mosaic of appropriate dimensions would be a measurable function of spectral composition.

5.   Publications and Presentations:
       No publications during this period.

6. <u>Expenditures from May 1, 1969 through October 31, 1969</u>:

Salaries	$ 5,494.00
Expense	965.00
Capital Equipment	<u>3,275.00</u>
Total Expenditures	$ 9,734.00

PROJECT A27

SCATTERING OF ALKALI METALS IN HIGH INTENSITY MOLECULAR BEAMS

1.   Department: Chemistry

2.   Principal Investigator: S. O. Colgate

3.   Background: This investigation is concerned with inferring the magnitude of the pair-wise intermolecular potential from measurements of the scattering occurring where a beam of alkali atoms traverses a gas-filled region. Total elastic scattering cross sections are measured as functions of the alkali beam energy, which is controlled by mechanical velocity selection.

The method of measuring total collision cross sections of alkali beams scattered by confined Maxwellian gases has been well established; the principal success, thus far, is the scattering gas density measurement technique developed in this work and the accurate measurement of several alkali atom-rare gas atom intermolecular potentials. With a sensitive thermocouple pressure gauge situated inside the scattering chamber, we have been able to measure scattering gas pressures in the submillitorr range to an apparent accuracy of $\pm$ 2%. Combining this result with other uncertainties in the scattering measurements, we obtain experimental cross sections to an accuracy of about $\pm$ 5%. Such cross sections are of great utility for inferring the actual magnitudes of intermolecular potential energies. Thus far we have velocity dependent data for several alkali metal-inert gas systems.

4.   Progress from May 1, 1969 to October 31, 1969: Because the collision energies are low in this experiment, the scattering is dominated by long range attractive forces. Each of the above systems behaves in reasonable accord with a model based on scattering by a potential of the form $U(r) = -C_6/r^6$, where r is the internuclear separation distance and C_6 is a parameter characteristic of the collision species. Values of the C_6 parameters deduced from the scattering experiments on the above systems agree, within the mutual limits of uncertainty, with theoretical estimates based on the polarizabilities of the interacting species.

A principal goal of the present research has been to utilize this technique to establish a set of standard cross sections and potential energies for a variety of collision pairs. Such a tabulation would provide useful reliability tests of theoretical potentials based on hypothetical models. Available data has already confirmed that existing theoretical methods of calculating spherically symmetrical atom-atom van der Waals potentials are quite accurate. Experimentally, averaged orientation-dependent atom-molecule collisions are as easy to measure as the simpler atom-atom ones, whereas the theories are necessarily much more complex. Reliable measurements for simple atom-molecule systems will greatly assist the evaluation of theoretical models. It is hoped that

techniques discovered to achieve compatibility between models and these systems will prove useful for permitting computation of molecule-molecule interactions which are presently known reliably from neither experimental nor theoretical means.

To achieve the greatest reward from our experimental efforts, we have concentrated on those systems which permit resolution into absolute values an abundance of relative cross section measurements made in other laboratories. By far the most accurate of these studies is that of von Busch and Strunck[1], who have compared the scattering of two different alkali beams passing simultaneously through a single inert scattering gas. We have confirmed their relative values for two pairs of systems: Cs - Ar, K - Ar; and Cs - Kr, K - Kr. With the data on the K - Kr system, which was obtained during the period of this report, we now have sufficient absolute measurements to resolve all of the relative measurements of von Busch and Strunck. These results are now being written up for submission to the Journal of Chemical Physics.

The magnitude of the cross section at a few different relative collision velocities is sufficient information to permit calculation of the C_6 parameter, but observations of the "glory" undulations in the total velocity dependent cross section due to the influence of the potential well would (if they exist for the system) help to determine the features of the well shape and location, and would also supply information about the number of bound vibrational states of the compound alkali metal-rare gas molecule. Detection of these undulations has proved to be quite difficult. The amplitudes of the glory extrema are small (eg. about 3% of the cross section for Cs - Xe) and of about the same magnitude as the scatter of the experimental data; thus the desired information is largely buried in the noise.

To facilitate observation of this quantum-mechanical phenomenon, the experimental technique has been modified. The Maxwellian scattering box has been replaced by a second beam arranged to intersect the alkali beam. The new cross beam source, which consists of a hypodermic needle and a slit to collimate the beam from the needle , is mounted on a bi-stable "see-saw" in such a manner that the crossed beam may be tilted reproducibly in or out of the alkali beam at will. The diminished time interval between measurements of scattered and unscattered beam intensity is expected to raise substantially the signal to noise ratio in the atom-atom impact spectra by decreasing the effect of drift in the intensity of the alkali beam with time. Dr. Robert Nelson, who is working in this laboratory, constructed the above modification to the apparatus, and he has also modified the data recording equipment to meet the more stringent requirements of this new experimental technique. Experiments using this technique are now under way on the K - Kr system.

[1] von Busch, Fr., Strunck, H. J.,Z. Physik, 209, 474 (1968).

Mr. Carl Smith, a graduate student in this laboratory, is using computer calculations to determine the exact contribution to the effective or density weighted length of the scattering chamber for various configurations of the entrance and exit slits.

A paper[2] on the experimental work of this laboratory was presented at the Sixth International Conference on the Physics of Electronic and Atomic Collisions, Cambridge, Massachusetts, July 28 - August 1, 1969.

5. Publications:
    Colgate, S. O. and Imeson, T. C., "Scattering of Low Velocity Neutral Particles; The Cs-He, Cs-Kr, and Cs-Xe Interactions", submitted to J. Chem. Phys.

    Imeson, T. C., Nelson, R. N. and Colgate, S. O., "Accurate Measurements of Total Scattering Cross Sections: Some Atom-Atom Interactions," VI-ICPEAC, 172 (1969) : paper orally presented at the conference.

6. Expenditures from May 1, 1969 through October 31, 1969:

Salaries	$ 4,245.61
Expense	1,598.02
Capital Equipment	1,837.80
Total Expenditures	$ 7,681.43

[2]Imeson, T. C., Nelson, R. N. and Colgate, S. O., VI International Conference on the Physics of Electronic and Atomic Collisions, 172 (1969).

PROJECT A28

ASTRONOMICAL INVESTIGATIONS OF THE GRAVITATIONAL FIELD

1. <u>Department</u>: Physics and Astronomy

2. <u>Principal Investigator</u>: Guy C. Omer, Jr.

3. <u>Background</u>: The basic problem is the nature of the gravitational field at moderate and great distances. It has been approached in two ways: first, from a study of the universe as a whole in attempting to solve the cosmological problem; secondly, from studies of clusters of galaxies, which is the cosmological problem in the small. If the gravitational field is stated in terms of the theory of General Relativity, then the problem is the plausible value to be assigned to the cosmological constant. In quasi-Newtonian terms, this somewhat controversial constant, if positive, results in a repulsive force which increases with distance as an additional term to the usual inverse-square attractive force.

Unfortunately, the cosmological problem has not been unequivocally solved. Perhaps the difficulty is that we are part of the system and therefore cannot view it as a whole from the outside. A solution can be found which looks reasonable from the criteria of average density of matter, age, rate of expansion, radius of curvature, and other factors, but which does not agree with Sandage's value of q_0, the departure from linearity of the Hubble relation. The solutions favored by Sandage, on the other hand, seem to have impossibly short ages and embarrassingly high average densities of matter.

Because of these apparent contradictions, we turned to a study of clusters of galaxies. This is a large subunit of the universe which can be studied from outside with the consequent hope of a more complete understanding. Yet the subunit is large enough that a departure from a Newtonian inverse-square force should be evident in the cluster dynamics. Our own preferred cosmological models require a small positive value of the cosmological constant. Sandage's models require either a zero or possibly a slightly negative value for the cosmological constant. Thus it is hoped that a study of cluster dynamics might allow us to decide the nature of the universe as a whole. Furthermore, the differences in average densities required in the two sets of models could be ascribed to either the presence or the absence of intergalactic matter. If the intergalactic material is in the form of stars, then its presence or absence must be sought in the cluster dynamics. However, if the intergalactic material were present as an ionized gas then it might be inferred from radio astronomy surveys.

There is surprisingly little known about clusters of galaxies that
is reliable and definitive. Most of the published information is based
upon casual inspections of the plates -- and in many cases even of the paper
prints of the Palomar Sky Survey. Thus an approach to the cosmological
problem through the clusters of galaxies must begin at the beginning.
First we must find out something about the clusters themselves.

4.   Progress from May 1, 1969 to October 31, 1969: Mr. C. F. LaForce
joined our group during this period. He is studying the cluster Abell
2256, using the $4° \times 4°$ Palomar 48" Schmidt plate taken earlier by the Principal
Investigator. He is now supplementing his work with plates taken with
the 30" reflector of the University of Florida Rosemary Hill Observatory.
He is searching for the optical source of the radio emission in this cluster
as well as other details. His analysis of Abell 2256 is not yet complete,
but this cluster appears to contain about 250 galaxies within a radius of
30' of arc. His integration of his counts to obtain the spatial distri-
bution of the galaxies in this cluster is also tentative, but appears to
be of the same form as that for the Coma, Hercules, and Abell 2199 clusters
previously analyzed by our group. Mr. LaForce is a candidate for the Master's
degree in Astronomy, and his work on Abell 2256 will comprise his thesis.

Mr. Eugene E. Clark is completing a doctoral dissertation entitled
"Observational Effects of Local Mass Inhomogeneities in Cosmological Models".
He is considering the perturbing effects of clusters of galaxies on the
null geodesics which pass near and through the cluster. Operating by the
familiar mechanism of the gravitational bending of light, the cluster will
function as a transparent lens. In this capacity, it changes the apparent
position, shape, and brightness of objects observed beyond the cluster.
Because of its proximity and large size, the Virgo cluster has been chosen
for detailed analysis. A metric has been calculated which represents, to
the first order, the interior spacial structure of this cluster. The
deflection angle of the null geodesic is calculated for this metric as a
function of the initial position and direction of the photon. The resulting
effects on apparent source position and shape are determined. The source
brightening which results from the deflection has been calculated as a
function of the angular distance of the source from the optical axis. Similar
calculations have been made for the Coma cluster.

Mr. Robert W. Davis has continued his theoretical studies of the Coma
cluster as a non-homogeneous cosmological model. This work will constitute
his Ph.D. thesis in Physics. It gives a plausible explanation of clustering
of galaxies as due to small density fluctuations during the initial epoch
of the expansion of the universe. It is also hoped to set some limits to
the possible values of the cosmological constant from an apparent change in
behavior from an oscillating cluster core to a slowly expanding cluster
periphery. He has also developed very useful calculational methods for
handling our cluster data, and has been the IBM programmer for our group.

The Principle Investigator has continued to work with the Hercules cluster of galaxies in conjunction with the radio astronomy group. Professor T. D. Carr's graduate student, Frank F. Donivan, has surveyed both the Hercules and the Coma clusters with the Arecibo radio telescope. Several joint papers have resulted from this cooperative arrangement, although conclusions are still indefinite. It is not established as yet whether the low-frequency radiation from the Hercules cluster is to be ascribed to a collection of point sources, or whether it also includes a broad source from the whole cluster. The point is crucial to the question of the existence of intergalactic matter and further work is in progress.

5. Publications: The following papers were presented at the annual meeting of the Southeastern Section of the American Physical Society held at Gainesville, from November 6 through the 8, 1969. Abstracts are in press in the Bull. Am. Phys. Soc.

LaForce, C. F., "The Cluster of Galaxies Abell 2256"

Davis, R. W., "Data Reduction for Clusters of Galaxies"

Donivan, F. F. Jr., Carr, T. D., and Omer, G. C.,Jr.,"Radio Mapping of the Hercules Cluster of Galaxies"

6. Expenditures from May 1, 1969 through October 31, 1969:

Salaries $ 3,572.00

PROJECT A29

GASDYNAMICS OF STRONG SHOCK WAVES

1. Department: Aerospace Engineering

2. Principal Investigator: B. M. Leadon

3. Background: The problem in broad view is to understand the structure of strong shock waves in various gases and gas mixtures. Many studies have been made of this overall problem, most of them during the past two decades but few of them concerned with precursor ionization mechanisms. Ionization ahead of the shock was observed first in metal shock tubes, later in glass shock tubes, and finally during spacecraft re-entry as a magnified radar target many times larger than the re-entering body. Theoretical calculations based on several proposed ionization or electron diffusion models were unsuccessful in predicting sufficiently high electron densities to account for the measured values prior to the calculations of S.S.R. Murty in this laboratory. Murty proposed a two-step ionization model in which resonant line radiation from behind the shock first excited and then ionized the gas throughout a large distance ahead of the shock wave. A principal feature of this model is that pressure broadening behind the shock permits photons from the wings of the broadened line profile to penetrate far ahead before being absorbed by the cold, low-pressure gas. Murty's calculations were done for monatomic hydrogen, 4.54×10^6 cm/sec. shock velocity and at a pre-shock number density of $10^{17} cm^{-3}$.

To test the reality of the two-step model, measurements of the absorption of radiation by the cold gas may be made simultaneously with measurements of electron number densities ahead of the shock wave. Since it is more convenient to work with argon than with dissociated hydrogen, Murty's calculations must be repeated, insofar as possible, for argon.

It has been suggested that a three-step process may provide an easier ionization mechanism than a two-step process. This possibility is regarded as one which should be explored on this project.

Preparations have been made in part for mass spectrometric analysis of the chemical state of gases following strong shock compression.

4. Progress from May 1, 1969 through October 31, 1969: Preparatory to the mass analysis of the shock structure the sampling probe, or "skimmer," was analyzed in some detail, since this device has proved to be a source of trouble when used in molecular beam experiments. Detailed calculations of collision probabilities within the "skimmer" were made. Shock wave passage over the exterior surface of the skimmer with subsequent dissipation in the cylindrical dump tank was analyzed to insure that premature

reflected shocks would not disturb the filament of gas being ingested by the skimmer and quadrupole mass analyzer.

Preliminary calculations of absorption of the 1067 $\overset{o}{A}$ line in argon at a pre-shock number density of $10^{16}cm^{-3}$ and a shock velocity of $.2 \times 10^6$ cm/sec. were made, with the conclusion that this should be observable experimentally. Preparations were made to attach a vacuum ultraviolet spectrometer to the end of the shock tube to obtain the time varying history of slit illumination by the shock-heated gas radiation as the wave advances toward the slit. Alignment and calibration devices have been designed and constructed. These preparations are 90% complete.

5. Publications and Presentations:
No publications during the period from May 1, 1969 through October 31, 1969.

6. Expenditures from May 1, 1969 through October 31, 1969:

Salaries	$ 6,261.00
Expense	1,211.00
Total Expenditures	$ 7,472.00

PROJECT A30

KINETICS OF EXCITED MOLECULES

1. Department: Chemistry

2. Principal Investigator: G. H. Myers

3. Background: The research in progress is concerned with the formation
and decay reactions of metastable excited molecular oxygen. We are using
a fast flow system with a microwave discharge to produce $O_2(a^1\Delta_g)$ and atomic
oxygen. The $b^1\Sigma_g^+$ state of O_2 is formed downstream from the discharge by
two $a^1\Delta_g$ molecules disproportionating to yield one $b^1\Sigma_g^+$ and a ground state
molecule. The relatively small concentration of $b^1\Sigma_g^+$ obtained is usually
a steady-state value determined by both the rate of formation from
$a^1\Delta_g$ and the rates of homogeneous and surface quenching reactions. Our
primary observation is the intensity of the $b^1\Sigma_g^+$ state at 7619Å, from
which we infer reaction rates for the excited molecular O_2 species.

4. Progress from May 1, 1969 to October 31, 1969: Due to the nature
of the steady-state kinetics of the $b^1\Sigma_g^+$, measurements of the decrease
of the 7619Å intensity as a quenching gas is introduced yields only
the ratio of the homogeneous and wall quenching rate constants, k_Q/k_w.
Previous workers have attempted to obtain absolute rate constants (k_Q or
k_w) by making absolute intensity measurements and estimating the rate of
$a^1\Delta_g$ disproporationation reaction. This type of indirect determination
has led to more than a factor of 10 uncertainty in the values of k_Q and
k_w reported. We have developed a new technique for obtaining k_w and k_Q
directly. This involves inserting into the flow a wire spiral which pre-
ferentially quenches the $b^1\Sigma_g^+$ state, so that a steady-state situation no
longer exists. The rate at which the $b^1\Sigma_g^+$ grows back in downstream from
this spiral is directly related to $k_w + k_Q[Q]$. We have been applying
this technique and have obtained a wall deactivation efficiency for $b^1\Sigma_g^+$
on Pyrex of 0.015, an order of magnitude greater that obtained by indirect
flow measurements, but in good agreement with a direct photochemical deter-
mination. We have calculated a bimolecular quenching rate constant for H_2O
of $4 \times 10^{-12}cc\ sec^{-1}$, again much faster than the indirect flow technique.
There are some as yet unpublished independent photochemical measurements
of H_2O quenching that agree very well with our results. We also find a
rapid quenching rate for CH_3OH, although this molecule also reacts with
the O atoms present in our system. We plan to use a HgO film to remove O
atoms in order to study the quenching by CH_3OH in the absence of this reaction.

In a separate series of experiments, we have attempted to make optical
absorption measurements of NO_2 trapped in an Argon matrix at 4°K. It has
been shown that the NO_2 is trapped with a non-random orientation in the matrix.
We had hoped to obtain polarized optical spectra which would be useful in elu-
cidating the electronic structure of NO_2. Previous ESR measurements have
indicated that the NO_2 is frozen out parallel to the surface on which the
matrix is formed. Our EST measurements, taken at much higher resolution,

indicate that some NO_2 are indeed oriented planar, but that other NO_2 are oriented non-randomly in other sites. This makes polarized optical spectral studies impossible, but it is an important finding for understanding matrix phenomena. We are currently analyzing our ESR spectra to determine the nature and relative concentration of these new sites.

5.   Publications:
O'Brien, R. J., and Myers, G. H., "Quenching of O_2^*," paper presented at the 158th National ACS Meeting, September, 1969

Myers, G. H. and O'Brien, R. J., Jr., "Quenching of $O (b^1\Sigma_g^+)$," paper presented at the International Conference on Singlet Molecular Oxygen and Its Role in Environmental Sciences, October, 1969

6.   Expenditures from May 1, 1969 through October 31, 1969:

Salaries	$ 4,703.76
Expenses	771.62
Capital Equipment	459.85
Total Expenditures	$ 5,935.23

PROJECT A33

VENTILATORY IMPLICATIONS OF PHONATION

1. Department: Physiology

2. Principal Investigator: A. B. Otis

3. Background: Although the primary function of breathing is to serve the respiratory needs of the body, an important secondary function in human beings is the part it plays in the production of sound--especially in speech. In our earlier work we have been concerned with determining to what extent the demands of these two functions may interfere with each other under stressful circumstances. An understanding of this is pertinent to any situation, such as space exploration, where communication by intelligible speech is required and where at the same time physical exertion may be demanded.

We have studied the affects of speaking on pulmonary ventilation and effects of pulmonary ventilation on speech. Also, we have determined the maximal possible frequencies of breathing at various tidal volumes. These studies relate to the speed and the intelligibility of speech. We have also made some studies related to the maximal rate at which subjects can receive information through the auditory system by determining the maximal rate at which subjects can accurately count the number of short bursts of sound presented to them. Our thought in these studies was that for optimal information the maximal rates of sending and receiving must be approximately matched.

4. Progress from May 1, 1969 through October 31, 1969: During the past six months we have been concerned with instrumentation. We have succeeded in getting the mass spectrometer in satisfactory operating condition so that we will be able to measure simultaneously the avalveolar P_{CO_2} and P_{O_2} and record changes that occur in these parameters during speech. We also obtained an analog computer which we hope to use as an on-line data processing instrument so that we may be able to read out moment-to-moment changes in the respiratory exchange ratio during speech; this will give a continuous indication of relative over-or under-ventilation. In addition, we have been given a second-hand tape recorder which, when renovated, will be useful for data storage. It will, for example, enable us to store the data from the mass spectrometer, which can then be played back at a slower speed on an X-Y recorder, the latter instrument being too slow to record faithfully the changes in P_{CO_2} and P_{O_2} as they actually occur.

5. Publications:
No new publications have resulted during the last six months.

6. <u>Expenditures from May 1, 1969 through October 31, 1969</u>:

Salaries	$ 1,800.00
Expense	256.00
OCO	<u>2,460.00</u>
Total Expenditures	$ 4,516.00

PROJECT A34

A STUDY OF SPECTRAL LINE BROADENING IN PLASMA

1. Department: Physics and Astronomy

2. Principal Investigator: C. F. Hooper, Jr.

3. Background: The shape of the broadened spectral lines emitted or absorbed by neutral and ionized gases is determined primarily by the interparticle forces present in the gas. Consequently, much effort has been devoted to the development of a theory which will accurately predict the shape of these lines. Such a theory would permit the observable characteristics of a given line (shift, width, etc.) to serve as noninterfering probes for a determination of the temperature, density, etc. of the gas. The purpose of research conducted in this program is to investigate the phenomenon of spectral line broadening in plasmas in a systematic manner which will eventually lead to a general theory capable of predicting complete line profiles in a unified manner (center-wings). Further, all approximations employed have been introduced in such a manner that systematic corrections can easily be made. To date, we have primarily employed the "relaxation theory" to pursue this problem, but we are currently also using Green function techniques; specifically, we are interested in ascertaining the relationship between these approaches and those previously formulated. A refined relaxation theory is being used to calculate Lyman profiles for both He II and H. The intention is to generate a general relaxation theory which is capable of explaining these relatively simple line shapes and which can then be extended to treat more complicated lines, such as those comprising the Balmer series and other non-hydrogenic lines.

4. Progress from May 1, 1969 to October 31, 1969: Research from the preceding six-month period has been continued. Improved line shape calculations for the Lyman-α line of hydrogen have been performed. The techniques developed for the Lyman-α line have been extended to the Lyman-β line. Efforts to include strong and quenching collisions have progressed to the point where the first rough calculations have been performed. Indications are that we will indeed be able to remove the necessity of using strong-collision cutoffs in line-broadening calculations.

The study of the effect of ion motion on line shapes has also reached a point where we have been able to make calculations. Preliminary results indicate that previous line-broadening theories have tended to underestimate the importance of ion motion.

The phase of research which has employed Green functions to study the line broadening problem (as originally outlined) is nearing completion. A paper summarizing the results will be submitted to one of the physics journals.

Electric microfields for two-component plasmas have been determined.
These will be used in calculations on the Lyman-α line of He II. Recent ex-
perimental observations of the He II Lyman-α line, at the University of
Maryland, make this problem more than academic.

5. Publications:
Dufty, J. W., "Charge Density Fluctuations in Spectral Line Broadening,"
(Phys. Rev., in press).

6. Expenditures from May 1, 1969 to October 31, 1969:

Salaries	$ 5,345.14
Expense	2,392.26
Total expenditures	$ 7,737.40

PROJECT A35

COLLISION CROSS SECTIONS AND LIFETIMES OF EXCITED STATES OF ATMOSPHERIC GASES

1. Department: Physics and Astronomy

2. Principal Investigator: R. C. Isler

3. Background: Two types of experiments are being pursued under the
current projects:
    1. Level-crossing spectroscopy of atoms and diatomic molecules.
    2. Optical excitation in low energy ion-atom and ion-molecule
collisions.

Experiments in level-crossing spectroscopy are performed by observing the
resonance radiation which is scattered by a cell of atoms or molecules as a
function of the strength of a magnetic field in which the absorption cell is
placed. Two or more atomic levels may be made to approach one another and
to cross by varying the strength of the field. The angular distribution of
light which is coherently scattered by two or more levels is a function of
their separation. If the angle of the exciting and reradiated beams is 90°,
a sweep through the level-crossing produces a field-dependent fluorescence
which has the shape of an inverted Lorentz curve. When the crossing occurs
at zero field strength.(i.e., for magnetic sublevels of the same angular
momentum state) the half width of the Lorentz curve is proportional to $g_j t$,
where g_j is the Lande g-factor for the state and t is its lifetime.

We have been investigating the lifetime of the $A^1\Pi$ state of CO because
of its astrophysical importance and because measurements of oscillator
strengths made by two independent methods[1,2] differ by a factor of 2.5.

Optical excitation of low-energy (<1000 ev) ion-atom and ion-molecule col-
lisions have attracted increasing interest in the last few years. Such studies
are important for gaining insight into fundamental collision theories for
heavy particles and for determining the importance of such collisions in the
excitation of planetary atmospheres. We have reported, so far, only observations
from He^+ + He and He^+ + N_2 systems which were made when trying to develop a
working apparatus. We are now beginning research into the excitation studies
of a wide variety of systems.

4. Progress fro May 1, 1969 to October 31, 1969:
    Investigations of level-crossing signals in the $A^1\Pi$ state of CO have con-
tinued during the past six months. The quality of the data and the accuracy
of the analysis have been greatly improved. Several sets of data have been
taken for the (1-0) and (2-0) bands of the $A^1\Pi \rightarrow X^1\Sigma$ transitions. Approxi-
mately 20 seconds are required to sweep over a level-crossing signal, and each
set of data represents at least 1-1/2 hours of running time, during which the
signals from several sweeps are accumulated in a Fabri-Tek model 1062 instru-
computer (signal averager).

[1]Hesser, J. E., J. Chem. Phys. <u>48</u>, 2518 (1968).

[2]Lassettre, E. N., Silverman, S. M., and Krasnow, M. E., J. Chem.
Phys. <u>40</u> 1261 (1964).

The long times used for averaging have reduced the noise to a few percent of the signal. A non-linear least squares fitting program has been used for the analysis of data, and under the assumption that the $A^1\Pi$ state is closely represented by Hund's case-a coupling scheme, the following values are obtained for the lifetimes of two vibrational levels for this state:

$$v = 1 \quad 18.6 \pm 1.7 \quad nsec$$

$$v = 2 \quad 9.3 \pm 0.9 \quad nsec$$

This lifetime for the $v = 1$ state is significantly longer than the lifetime (1016nsec) reported in the previous period, from preliminary analysis. However, the present analysis is much more reliable owing to the vastly improved quality of the data.

The lifetime for the $v = 2$ state agrees with Hesser's measurement and indicates that Lassiter's f-values for the $A^1\Pi$ state are not correct. The fact that the lifetime for the $v = 1$ state appears to be twice that for $v = 2$ reflects a major difficulty in all experiments done in the $A^1\Pi$ state. This state is strongly perturbed by many other levels of the CO molecule, and the f-values and lifetimes may vary widely for various rotational levels within a given vibrational level. The present level-crossing technique emphasizes contributions from the lower rotational levels of the band under observation. In the $v = 1$ state these bands are known to be perturbed by the $d^3\Delta_i$ ($v = 5$) state. The mixing coefficients are not known and it is impossible at the present time to estimate the effects of such mixing on lifetime measurements. The lower rotational states of the $v = 2$ level are not perturbed, however, and the present lifetime measurement should be reliable within the experimental uncertainty.

Level-crossing studies have been started on the $(3p^54s)^3P_1$ state of argon. There are several calculations and measurements of the lifetime of this state; they vary from 8.6 nsec to 21.0 nsec. We have made observations with the pressure in the scattering cell between 5×10^{-4} torr and 1×10^{-2} torr. At the upper end of this range pressure broadening is observed to widen the level-crossing signal, but from 5×10^{-4} torr to 5×10^{-3} torr the signals appear to be independent of the pressure and imply an average lifetime of $7.8 \pm .6$ nsec. This measured lifetime cannot be said to be the true lifetime of the state until possible effects of coherence narrowing are more thoroughly investigated.

Studies of ion-atom collisions have been directed toward the $He^+ + Ar$ reactions which lead to excited states of the products. Spectral scans at 5 Å resolution have been made from 3500 Å to 8500 Å with an incident ion energy of 200 ev. The most prominent features in this range are spectral lines from ArII, as reported by other workers. However, we have also been able to isolate and observe spectral lines from HeI and ArI. Relative excitation cross sections have been measured for the ArI 7635 Å line and the ArII 4610 Å line with energies of incident He^+ ions in the range from 0-300 ev. Both of these lines exhibit sharp onsets slightly above the threshold for excitation, a behavior which disagrees with Massey's adiabatic criterion. This behavior has been observed previously for charge exchanged

products, but the present observations on the ArI line are the first to demonstrate similar divergences from adiabatic behavior for direct excitation.

5.   Expenditures from May 1, 1969 through October 31, 1969:

Salaries	$ 3,389.22
Expense	1,310.00
Capital Equipment	27.67
Total Expenditures	$ 4,726.89

PROJECT A36

ANTECEDENT DETERMINANTS OF THE SLEEP RESPONSE

1. Department: Psychology

2. Principle Investigators: W. B. Webb and J. K. Mallory

3. Background: The purpose of this project is to examine and utilize the sleep of rodents and lower animals to determine the fundamental biological characteristics associated with the sleep-waking cycles. This particular procedure has the critical advantage of studying an "open ended" system in which sleep and waking operates as a free system. The sleep process is independent of social structuring and task demands which are imposed on human subjects. In short, sleep and waking can occur on a basis independent of interfering "noise" or "zeitgabers" imposed by social routine. Of course, the utilization of the lower animals further permits the increased control of the history and immediate antecedent conditions of the subject and further permits more extended manipulations of experimental variables.

We believe that the utilization of the rodent in the study of the underlying substrata of sleep is critical relative to space flight since space flight will remove social and temporal structures of the human subject and will furthermore, permit the total manipulation of the subjects immediate environment.

4. Progress from May 1, 1969 through October 31, 1969: Using the index of rodent sleep previously developed in this laboratory it was determined that across a 24 hour period in a confined EEG recording setting the length of successive sleep and waking episodes shows no direct relationship. These data imply a limitation to the hypothesis of sleep as a simple energy restoration or storage period. These findings were published in "Psychonomic Science."

A Masters thesis, "Contingencies of Sleep Deprivation" was completed. A long term water wheel partial sleep deprivation procedure was found to leave no enduring effect on sleep patterns. While a shorter sleep contingent shock method yielded a small but nonenduring inversion of the light dark cycle.

These results implicated genetic determinants of sleep. Therefore, two rat strains inbred for 76+ generations were recorded and these data were found to be virtually non-overlaping, on any of the sleep parameters used. In contrast to normative sleep data, the variance within both strains was quite small, further supporting genetic determinancy of sleep patterns. This paper was reported to the Psychonomic Society, St. Louis, 1969.

Another paper is currently in press dealing with paradoxical or "dream" sleep in the rat. We conclude in it that (1) paradoxical sleep differs during light and dark phases;

(2) the longer the sleep episode the greater the probability of paradoxical sleep; (3) the intra-sleep appearance of paradoxical sleep is cyclical and independent of sleep length. Sleep in the rat appears to be a regular cyclical firing with no tendency towards increasing strength of paradoxical sleep, either in terms of shorter intersleep intervals or longer episode lengths.

5.   Publications and Presentations:
Webb, Wilse B. and Friedmann, J., "Length of Sleep and Length of Waking Interrelations in the Rat", Psychonomic Science, 1969, 17:14-15.

Friedmann, Joyce Kendall, "Contingencies of Sleep Deprivation" Masters Thesis, University of Florida, 1969.

Webb, Wilse B. and Friedmann, Joyce, "Sleep of Two Inbred Rat Strains", presented at the annual meeting of the Psychonomic Society, St. Louis, Missouri, November, 1969.

Webb, W. B. and Friedmann, J. K., "Characteristics of Paradoxical (LVF) Sleep in the Rat", EEG Journal, in press.

6.   Expenditures from April 1, 1969 to November 30, 1969:

Salaries	$ 613.71
Expenses	498.35
Total Expenditures	$1,112.06

PROJECT A38 (a)*

PARTICIPATION AND EVALUATION OF PERFORMANCE OF THE
SCIENTIST-PROFESSOR IN THE NASA PROJECT

1. Department: Sociology

2. Principal Investigators: Sugiyama Iutaka and E. Wilbur Bock

3. Background: Universities have played an important role in the
development of science in this country. Although research on campuses
is determined to some extent by individual preference on given themes
or topics, society has been one of the major propulsors of the direction
of scientific development. The NASA space effort has been one of the
most important undertakings, involving not only the Space Centers but
also industries and universities. On the other hand, domestic social
problems have become so acute that questions have been raised as to whether
or not the total available money and talent should be oriented towards
the solution of societal problems. However, it is important to know
how the individuals involved in the process of developing knowledge react
to this debate. The group under study in this investigation is composed
of scientist-professors. Since the scientist on campus, whether or not
he is involved in a local NASA project, has at least one other role (that
of professor) that is theoretically as important as the role of the
scientist, such a double role may condition his perception regarding the
role of science in society.

The objectives of the study are: (1) perception of the conflict between
the role of the scientist and professor; (2) reasons why the scientist-
professor decided to engage in the NASA project; (3) the importance of the
NASA project in individual careers; (4) the relative importance the
scientist-professor gives to the NASA project vis-a-vis applied research
for solution of societal problems.

The population under study is composed of three groups: those who
were directly engaged in a local NASA project (28) in the University of
Florida; and second and third groups (54) which serve as controls. One of
the latter groups consists of scientists not involved in a NASA project
on campus, while the third group is formed of scientists in the Space
Centers.

4. Progress from May 1, 1969 through October 31, 1969: All individuals
at the University of Florida (28) who received NASA grants were interviewed
personally. A control group (28) was also interviewed at the University of
Florida. The criteria for selection of the latter were: (1) same discipline,
and (2) same rank. Another control group interviewed consisted of off-campus
scientists working in NASA projects at the Goddard Space Center (12) and the
Marshall Space Center (14).

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*This is a two-part project being carried on jointly by the Departments of
Sociology, Management and Business Law; see also Project A38 (b).

Upon completion of the field work, a coding system was developed to compare these three groups regarding the objectives mentioned above. Some of the information collected is not directly comparable because the working situations are different. However, most of the data are comparable and were coded accordingly. The coded material was punched on IBM cards to be processed by the computer. The statistical analyses being used are (1) descriptive statistics for simple comparisons of the characteristics of the three populations; (2) factor analysis to determine the major dimensions of role-conflict, committment to science, committment to societal problems, and job satisfaction; (3) covariance analysis to determine the importance of belonging to one of these subpopulations; and (4) regression analysis to determine the factors related to the above points (1-3).

5. Publications:
    Dissertation: George A. Watkins, graduate student in sociology is participating in the project, and his dissertation will come from this investigation.

    A general report is in progress and will present the major findings of the present research.

    An article entitled "Committment to Science Among University and Non-University Scientists" is being prepared.

6. Expenditures from May 1, 1969 through October 31, 1969:

Salaries	$ 2,251.84
Expense & Services	3,759.79
Travel	882.65
Total Expenditures	$ 6,894.28

PROJECT A38 (b)

DEVELOPMENT OF PERFORMANCE CRITERIA FOR SCIENTIST-PROFESSORS IN NASA PROJECTS

1.   Department: Management and Business Law

2.   Principal Investigators: W. M. Fox and W. A. Hill

3.   Background: The United States spent 0.9% of its Gross National Product on research in 1940, 1% in 1950, 2.5% in 1960, and 3% in 1965 -- dramatic evidence of the growing importance of our investment in research. Yet, little study has been devoted to the development of viable means for controlling such activity; i.e., establishing evaluation criteria which are both acceptable to researchers and sufficiently reflective of contribution, as well as developing reliable and valid methodologies for generating rating relative to such criteria. Although several surveys have been made of the practices of certain organizations, no systematic and rigorous survey of the preferences of researchers themselves has been conducted to determine the specific criteria and methodologies for their assessment which would be seen as equitable by the researchers.

4.   Progress from May 1, 1969 to October 31, 1969: Intensive personal interviews were conducted with researchers and research directors in over twenty organizational units for the purpose of developing a questionnaire to elicit criteria which might be appropriate in assessing research performance as well as methodologies useful in measuring progress toward these criteria. The investigators' overall impression of these interviews was that, with few exceptions, the research personnel were reluctant to deal with the assessment problem except to say that it was a difficult one. Most interviews began with the premise that research effectiveness could not be measured. The tendency for individual researchers to insist that they are the only ones competent to evaluate their work seems to have been institutionalized by research directors. It would seem that a research director could be more effective in assessing performance if he requested his researchers to justify why no one could assess their performance, rather than accepting the premise. Justification should be based on contribution to organizational aims. Thus, the director could more effectively connect the goals of individual researchers to that of the organization. This procedure would allow the research director to set project priorities and facilitate the allocation of scarce resources.

After these discussions, a questionnaire was constructed and disseminated to researchers at the University of Florida and at two NASA installations, Goddard and Marshall. Each of the researchers was asked to assume the role of a director of a pure or basic research group and to list the factors he would use to determine the amount of contribution his subordinates had made. Then the respondent was shown a list of criteria prepared by the principal investigators and was asked if he wished to add any of these factors to his list. Each respondent then was asked to rank all of the factors on his list according to their relative importance. After each factor was ranked, the researchers

were requested to describe the methodology they would use to develop a judgment or a score for that factor. Each respondent then was asked to assume the role of director of an applied or development research group and to repeat the aforementioned procedure. Twenty-five NASA and 53 University of Florida researchers completed the questionnaires.

The respondents offered over 63 different criteria for assessing research performance, although many of these were overlapping both within individual as well as between individual researchers.

The most frequently cited criterion for assessing research performance was the individual's contribution to the development capabilities of other members. Other frequently mentioned criteria were value of innovation to scientific knowledge, attainment of research goals ahead of schedule, attainment of research goals below budgeted costs, and winning contracts in competition with other research organizations. Although these factors were frequently reported, rarely was any of these factors, with the exception of value of innovation to scientific knowledge, rated the most important. This designation was usually given to a factor which could be described as quality of work performed or in progress. Innovative ability and number and quality of papers and reports were other responses which were ranked most important by the respondents.

The methods of evaluation suggested by the respondents, in the order in which they were mentioned most often, could best be classified into three major categories: subjective evaluation by the director, objective (quantitative) evaluation by the director, and reliance by the director on the subjective evaluations of others (experts, peers, and colleagues). There was a tendency for respondents from NASA to prefer objective criteria more often than university personnel, but to indicate a preference for subjective evaluations by peers much less often. Not one researcher indicated that a minimum level of performance must be attained by his subordinates.

Examination of the responses indicated a frequent inability to separate criteria, per se, from a method of measuring performance on the criteria. Suggested ways of measuring performance on criteria rarely reflected a viable modus operandi. One prevalent trend throughout the data was confusion between personal characteristics of the researcher and his contribution. The criteria of "initiative" and "good interpersonal relations," for example, were mentioned as ways of assessing performance. These may be useful behaviors, but only if they result in some tangible, organizationally relevant output.

The information received from initial interviews and questionnaire responses has enabled the investigators to develop an improved set of criteria which are organizationally, rather than individual researcher, oriented.

We now plan follow-up contact with respondents both on and off campus to determine:

1. If a viable differentiation can be made between those data which represent "contribution behaviors" and those which represent means for measuring these behaviors.

2.   What priorities will be assigned by researchers in different milieus once the differentiations above are made.

    3.   Dissonance between the views of research administrative personnel and their research subordinates with regard to criteria and methodologies.

    4.   The similarity of responses from various European research groups with those of groups doing similar work in the States (Dr. Hill will be able to explore this while based in England under a research appointment).

5.   Publications: We have been approached by a research director of the American Management Association about making the data developed in this study available in the form of an AMA Research Publication.

    Dr. Fox presented some of our findings in the Workshop Discussion on Methodology of Research on Research of the COLRAD Group at the Tenth American Meetings of the Institute of Management Sciences in Atlanta, October 2nd. The Chairman, Dr. Albert H. Rubenstein, expressed an interest in the possibility of including a report on our work at the American meetings next year.

6.   Expenditures from May 1, 1969 through October 31, 1969:

Salaries	$ none
Expenses	2,595.00
Capital Equipment	none
Total Expenditures	$ 2,595.00

PROJECT A39

SCIENTIST'S ROLE IN SOCIETAL PROBLEMS

1. <u>Department</u>: Aerospace Engineering

2. <u>Principal Investigator</u>: M. H. Clarkson

3. <u>Background</u>: This project is concerned with defining a program that would bring the scientist and engineer into societal problems in a meaningful way. The approach has been to work with a multidisciplinary group including members from Sociology, Business Administration, Physics and Astronomy, and Engineering.

4. <u>Progress from May 1, 1969 through October 31, 1969</u>: Direct work on this project has not been active since the last reporting date. However, certain of the concepts that were developed have been utilized in the preparation, during the present report period, of an extensive proposal for practical utilization of on-campus research results. This proposal was submitted to NASA in early November.

5. <u>Publications and Presentations</u>: No publications during the period from May 1, 1969 through October 31, 1969.

6. <u>Expenditures from May 1, 1969 to October 31, 1969</u>:

        Expense $ 391.00

PROJECT A41

METABOLIC RESPONSES TO THE STRESS OF OXYGEN AT HIGH PRESSURE

1. Department: Physiology

2. Principal Investigator: Melvin J. Fregly

3. Background: Continuous exposure to pure oxygen at greater than 0.7
atmosphere is fatal to animals within a matter of hours. Although
there is a great deal of information regarding the toxicity of contin-
uous exposure, little information is available regarding either the
tolerance or the metabolic responses of laboratory animals to intermittent,
daily exposures to oxygen at high pressure. Such information could help
to establish dose-response relationships between the duration of inter-
mittent exposure to oxygen at high pressure and the physiological and
pathological effects resulting from it. Knowledge of this relationship
may be applicable to those situations, including radiation therapy,
exploration of ocean depths, etc., where oxygen at high pressure may be
used for short intervals of time. The tolerance limit in terms of
oxygen pressure and duration of exposure, as well as the effect of such
exposures on metabolic activity, are the focal points of this research.
In addition, a study of cross-adaptation between certain physiological
stresses is being undertaken. For example, the possibility that inter-
mittent exposure to oxygen at high pressure might provide cross-tolerance
to other stressful situations, e.g., exposure to cold, hypoxia or hyper-
tension, is under study.

4. Progress from May 1, 1969 through October 31, 1969:   Two separate
but similar experiments were carried out to test some physiological
effects of intermittent exposure to oxygen at high pressure. In the
first experiment, rats were exposed for 37 days to 1 atmosphere of oxygen
for 1/2, 1 or 2 hours daily, while in the second, rats were exposed for
28 days to 2 atmospheres of oxygen for the same daily exposure schedule.
In both experiments individual food and fluid intakes, as well as body
weight, were measured daily throughout the experiment. During the last
week of the second experiment, colonic temperature and heart rate of each
rat were measured. At the end of each experiment all rats were administered
7 uc of ^{131}I and killed 24 hours later to assess the state of activity of
the thyroid gland. At death, the thyroid gland was removed, weighed and
radioactivity measured in a scintillation detector. In addition to the
thyroid gland, heart, kidneys and adrenal glands were removed and weighed.

Intermittent exposure to 1 atmosphere of oxygen for 2 hours reduced
both food intake and body weight of this group below that of controls,
while exposure for either 1/2 or 1 hour had no significant effect. The
weight of the adrenal glands appeared to increase in proportion to the
increase in time of exposure to oxygen. The weights of heart and kidneys,
as well as the uptake of ^{131}I by the thyroid gland, were unaffected by
the treatments.

Thus, the most striking effect of exposure to 1 atmosphere of oxygen occurred in the group exposed longest (2 hours). The effect was a reduction in food intake and body weight gain. Changes in activity of the thyroid gland, as assessed by uptake of ^{131}I and by thyroid weight, were not affected by exposure to 1 atmosphere of oxygen. Histological analysis of the thyroid gland, heart and kidneys, to be performed, will be used to confirm these conclusions.

Intermittent exposure to 2 atmospheres of oxygen reduced body weight and daily water intake in the groups exposed for either 1 or 2 hours. Mean colonic temperature and heart rate of all treated groups were reduced below that of controls. Exposure to 2 atmospheres of oxygen had no significant effect on heart, adrenal, thyroid or kidney weight ratios for any group. Uptake of ^{131}I by the thyroid glands of all 3 treated groups was depressed by exposure to 2 atmospheres of oxygen. It would thus appear that exposure of rats to 2 atmospheres of oxygen for either 1 or 2 hours daily for 28 days is accompanied by signs of physiological distress. In addition, changes in activity of the thyroid gland, as assessed by uptake of ^{131}I, suggest that secretion of thyroxine may be affected.

Other studies have been carried out to assess the effect of the stress of exposure to cold on water exchange in rats. Dehydration, which accompanies exposure of rats to cold air, is manifested by increases in serum osmolality and chloride concentration and in a thirst following removal from cold. In addition, more urine is excreted for a given water intake by cold-exposed than by control rats. To assess renal concentrating ability, cold-exposed rats were either administered pitressin (antidiuretic hormone, 200mU) or dehydrated for 24 hours. The greater urinary flow rate observed in cold-exposed rats was reduced by each of these treatments but remained significantly above control level. In addition, urinary flow rate of cold-exposed rats was greater for a given urinary osmolality than was that of controls. Thus, chronically cold-exposed rats do not concentrate their urine to the same extent as controls. The fact that a greater urinary flow rate accompanied both administration of pitressin and dehydration of cold-exposed rats suggests that renal tubular response to antidiuretic hormone is attenuated by cold. However, reduced production of antidiuretic hormone and changes in renal hemodynamics are not excluded by this experiment. The thirst mechanism of cold-exposed rats appears to be intact as judged by spontaneous water intake at either 1 or 2 hours following a 24 hour dehydration. While other tests are necessary, present results suggest that alteration in the relationship between water intake and urinary output observed during exposure to cold is more closely related to renal than to thirst factors. The results of this study have been prepared in manuscript form and will be submitted for publication shortly.

Cross-adaptation between the stress of hypoxia and renal hypertension was studied in rats. Exposure of rats to an atmosphere containing 13% oxygen immediately after induction of hypertension prevented the elevation of systolic blood pressure to the level of hypertensive controls maintained in an atmosphere containing 21% oxygen. The protection afforded remained

only as long as the rats were exposed to hypoxia. Following return to 21% oxygen, mean blood pressure of the treated group was identical with that of untreated controls within two and one-half weeks. Paired feeding of the control animals to match their food intake with that of the rats exposed to 13% oxygen assured that the protective effect of hypoxia was not related to an accompanying anorexia. The mechanism responsible for the protection observed is unknown but may be associated with one or a number of the physiological and biochemical changes induced by hypoxia. The results of this study have been prepared in manuscript form and will be submitted for publication shortly.

5. Publications:
   Fregly, M. J., Renal concentrating ability of rats exposed to cold, Federation Proceedings <u>28</u>, 791 (1969).

   Fregly, M. J., Comments on cross-adaptation, Environmental Research <u>2</u>:435-441 (1969).

6. Expenditures from May 1, 1969 through October 31, 1969:

Salaries	$ 1,893.07
Expense	1,157.30
Capital Equipment	46.13
Total Expenditures	$ 3,096.50

PROJECT A52

CARDIOVASCULAR RESPONSES TO STRESS

1. Department: Psychiatry

2. Principal Investigator: George W. Barnard, M.D.

3. Background: In a previous project we found that the human physiological system is composed of a series of subsystems which operate with different rates of physiological lag in response to stess. This means that one subsystem may contain little lag, so that one can measure a physiological response which is relatively uncontaminated by previous responses. On the other hand, other physiological subsystems have a high degree of lag, and this is carried over to the next response to stress and thereby contaminates the results. To quantify the lag, we developed a statistical method for deriving the coefficient of response relevance (CRR).

In the first study, this method was applied to the heart rate and systolic blood pressure data obtained from subjects undergoing serial stressors. The results indicated a CRR for heart rate of 0.84 and for blood pressure (ear) of 0.25. Our tentative conclusion was that heart rate was highly relevant, with little physiological lag, but blood pressure contained higher levels of lag. Since it was not clear whether the low value obtained for blood pressure was due to an instrumental factor or to a true physiological lag, a more controlled study was performed.

In the second study, 50 normal male subjects were exposed to serial stressors with each stress preceded by a rest period and an anticipation period and followed by a recovery period. Altogether there were thirty definable periods. Heart rate was recorded continuously and mean heart rate per minute was obtained on printout. Both systolic and diastolic blood pressures were measured once per minute by standard clinical methods. The data was analyzed with means and standard deviations obtained for each period. A correlational analysis for each physiological measure, (heart rate, systolic blood pressure and diastolic blood pressure) was performed for the thirty periods of measurement. Using this data we then derived the coefficient of response relevance for each variable. Prior to analyzing the data we had predicted that heart rate would show much less physiological lag than systolic blood pressure and therefore would earn a higher coefficient of response relevance score. Our predictions were confirmed with heart rate CRR = 0.88 and systolic blood pressure CRR = 0.36. An unexpected finding was diastolic blood pressure CRR = 0.76.

4. Progress from May 1, 1969 to October 31, 1969: Having demonstrated to our satisfaction that heart rate was relatively free of physiological lag, we sought ways of further defining the internal oscillations for this subsystem. In our earlier work we could not find a commercially available

instrument to give mean heart rates per minute in printed form, so we
built our own device. At the same time we began development of a
digital beat-by-beat cardiotachometer. The beat-by-beat component
was not ready for use in the prior study, so we used our minute counter
and printer. Further development on the beat-by-beat cardiotachometer
has been accomplished and we can report on the technical details.
Using the mathematical logic of a cardiotachometer by Major Adolph W.
Foeh, Jr., USAF School of Aerospace Medicine, Brooks AFB, Texas, we
sought to implement and redesign the digital logic using Signetics
and Fairchild integrated circuits. Conceptually, the design consists
of a binary counter, a BCD counter, clock and timing logic and digital
logic which generates control pulses dependent on the contents of the
binary counter. A cycle of operation, which is repeated for each R-R
interval, is as follows: Each input heart beat resets the binary counter
to a value such that at the end of 300 milliseconds the counter contains
the number 200 (300 milliseconds is the length of time corresponding to
200 beats per minute). After the 300 millisecond delay, the binary counter
is triggered by clock pulses and counts down. If selected pulses are
prevented from triggering the counter, it can be made to count down at
a hyperbolic rate and thus maintains step with integer values of heart rate
from 200 down to 40 BPM. This is achieved by logic based on the present
count in the counter, which functions as a tabulator of the amount of time
elapsed since the previous heart beat. The logic generates signals which
control the length of time between pulses of the variable length pulse
generator. When the next R wave of the heart beat arrives, the correct
rate is contained in the counter. The BCD down counter is slaved to the
binary counter and receives pulses only when the binary counter receives
pulses. It is also initialized to 200 and counts down in a decimal mode
so that when the next R wave arrives,the correct rate is contained in the
BCD counter and is gated out to the buffer by a pulse coincident with the
next heart beat.

This digital cardiotachometer has a linearity of $\pm$ 1 beat in
monitoring heart rates from 40 to 200 beats per minute. With this degree
of sensitivity and accuracy, we are now in a position to analyze the
oscillations of the cardiovascular system in a discriminative manner which
was not possible previously. We can monitor the beat-by-beat variability
visually with the numeric display. We have also tied the system to an IBM
1800 computer by means of cable. The computer program has been developed
to process the data and then, with the IBM 360, obtain a hard copy printout.
The system is designed so that we can process data from six subjects simul-
taneously. This means that we can now begin to analyze data from small
groups of subjects as well as individual subjects. In our next phase of
development, we plan to incorporate principles of operant conditioning.
In these experiments,individuals' cardiovascular response to positive
reinforcement and aversive techniques will be obtained.

5. Publications and Presentations:

Barnard, G. W. and Garrett, R., "Heart Rate Monitoring in Groups," Scientific exhibit Annual Meeting, American Psychiatric Association, Miami, Florida, May 4-9, 1969.

Barnard, G. W., "Physiological Response Relevance," submitted to American Psychosomatic Society.

6. Expenditures from May 1, 1969 through October 31, 1969:

Expenses	$ 3,380.97
Capital Equipment	455.41
Total Expenditures	$ 3,836.38

PROJECT A53

PROGRAM FOR A MAJOR RADIOASTRONOMICAL ARRAY

1. Department: Astronomy

2. Principle Investigators: A. G. Smith and T. D. Carr

3. Background: The University of Florida Radio Observatory has made major contributions to the knowledge of the decameter-wavelength radio emissions from the planet Jupiter. Because of the unavailability of suitable antennas of large effective area for low-frequency monitoring, practically all such work here and elsewhere has been done with relatively small antennas (i.e. those having effective areas not exceeding a few hundred square meters). In order to investigate the lower intensity levels, we have undertaken the construction of a very large phase-steered antenna array, to operate at 26.3 MHz. It will consist of 640 half-wave dipoles, and will have an effective area of about 30,000 square meters. This array will also open up other extremely promising avenues of investigation, as for example, the search for radio bursts from Saturn and other planets, and studies of radio emission from pulsars and flare stars. The array can also be used in conjunction with a smaller moveable antenna to produce an interferometer of high sensitivity and resolution.

Prior to May 1, 1969, the 8-acre array site had been cleared and levelled, the antenna masts installed, and preliminary designs had been made of components and methods of matching and phasing.

4. Progress from May 1, 1969 to October 31, 1969:
    a. The ground has been thoroughly poisoned with weed inhibitor.

    b. The ground plane has been laid.

    c. Approximately 400 of the 640 dipoles have been constructed and erected.

    d. The prototype matching network has been developed and tested, and it is ready to be put into production.

    e. After undergoing several stages of evolutionary development, a suitable method of interconnection and phasing has been decided upon. The large array will be composed of 80 sub-arrays consisting of 8 dipoles each. The 8 signals in each sub-array will be merged through 7 hybrid rings. Steering of the sub-array beam (coarse steering) will be accomplished by plugging in appropriate phasing links. The 80 trunk lines from the sub-arrays will be merged and phased through a system of Butler matrices (recommended by Prof. G. W. Swenson of the University of Illinois and Prof. W. C. Erickson of the University of Maryland's Clark Lake Observatory). Multiple 3° X 6° beams can be used simultaneously; 3 or 4 beams will probably be the practical limit. Fine steering, within a previously selected region of the sky, will be accomplished by the observer by remote control.

Swinging the beams to a region of sky more than about 40° away will require the replacement of a large number of plug-in phasing cables in the field. Approximately 300 of the 560 hybrid rings required for the sub-arrays have been constructed. The Butler matrices have been designed but not tested. It is expected that 64 dipoles (10% of the array) will be operating within two months, and will be used to monitor Jupiter during the approaching 1970 apparition.

5. Publications: none

6. Expenditures from May 1, 1969 through October 31, 1969:

Salaries	$ 4,703.38
Expenses	114.90
Total Expenditures	4,818.28

SUMMARY OF PROJECT PUBLICATIONS DURING THE REPORT PERIOD

Project A06

Keefer, D. R., "A Theory for the Low-Pressure Electrodeless Discharge," AIAA 2nd Fluid and Plasma Dynamics Conference, San Francisco, California, June 16-19, 1969, AIAA Paper No. 69-703.

Project A19

Chen, Kwan-Yu and Rhein, Walter J., "Temperature Distributions on the Surfaces of Close Binary Stars," Publ. Ast. Soc. of the Pacific, 81, 387-398, 1969.

Project A27

Imeson, T. C., Nelson, R. N. and Colgate, S. O., "Accurate Measurements of Total Scattering Cross Sections: Some Atom-Atom Interactions," Sixth International Conference on the Physics of Electronic and Atomic Collisions, Cambridge, Massachusetts, July 28 - August 1, 1969.

Project A36

Webb, W. B. and Friedmann, J., "Length of Sleep and Length of Waking Interrelations in the Rat," Psychonomic Science, 1969, 17: 14-15.

Project A41

Fregly, M. J., "Renal Concentrating Ability of Rats Exposed to Cold," Federation Proceedings 28, 791(1969).

Fregly, M. J., "Comments on Cross Adaptation," Environmental Research 2, 435-441 (1969).

Project A52

Barnard, G. W. and Garrett, R. "Heart Rate Monitoring in Groups," American Psychiatric Association, Miami, Florida, May 4-9, 1969.

FISCAL REPORTS SUBMITTED
DURING THE REPORT
PERIOD

GRANTEE QUARTERLY CASH REQUIREMENT REPORT

June 30, 1969

TO: Grants and Research Division
        Office of Space Science Applications
        · NASA
        Washington, D. C. 20546

FROM: University of Florida
        13 Tigert Hall
        Gainesville, Florida 32601

                        GRANT NUMBER: UF# 297*A50
                                         NSG 542

Amount of award: $ 1,800,000.00

Expended this quarter: 24,464.00

Expended to date: 1,588,538.00

Anticipated expenditures next quarter: 30,000.00

Cash received to date: 1,589,074.00

Cash required next quarter: 29,464.00

                                        /s/ Leo J. Myers
                                        Fiscal Contract Officer

GRANTEE QUARTERLY CASH REQUIREMENT REPORT

September 30, 1969

TO: Grants and Research Division
         Office of Space Science Applications
         NASA
         Washington, D. C.   20546

FROM: University of Florida
         13 Tigert Hall
         Gainesville, Florida 32601

GRANT NUMBER: UF# 297*A50
                NSG 542

Amount of award:	$ 1,800,000.00
Expended this quarter:	54,756.00
Expended to date:	1,643,294.00
Anticipated expenditures next quarter:	55,000.00
Cash received to date:	1,618,538.00
Cash required next quarter:	79,756.00

/s/ Leo J. Myers
Fiscal Contract Officer